

Claims

- [c1] What is the claimed is:
- 1.A method for manufacturing a light emitting diode having a transparent substrate, the method comprising:
- forming a semiconductor multilayer on a first substrate producing a first multilayer structure;
- forming an amorphous interface layer on a second substrate, the second substrate being transparent in nature, producing a second multilayer structure;
- bonding the first multilayer structure to the second multilayer structure, producing a third multilayer structure; and
- removing the first substrate from the third multilayer structure.
- [c2] 2.The method of claim 1 further comprising a step of forming a transparent conductive layer on the third multilayer structure after removing the first substrate.
- [c3] 3.The method of claim 1, wherein the amorphous interface layer is made of at least one selected from a group comprising indium tin oxide, indium cadmium oxide, indium tin oxide, and transparent conductive adhesive agent.
- [c4] 4.A method for manufacturing a light emitting diode, comprising:
- forming a semiconductor multilayer on a first substrate producing a first multilayer structure;
- forming an amorphous interface layer on a second substrate, the second substrate being transparent in nature, producing a second multilayer structure;
- bonding the first multilayer structure to the second multilayer structure, producing a third multilayer structure; and
- removing the first substrate from the third multilayer structure.
- [c5] 5.The method of claim 4 further comprising a step of forming a transparent conductive layer on the third multilayer structure after removing the first substrate.
- [c6] 6.The method of claim 4, wherein the amorphous interface layer is made of at least one selected from a group comprising indium tin oxide, cadmium tin

oxide, antimony tin oxide, and transparent conductive adhesive agent.

[c7] 7.A light emitting diode having a transparent substrate, the light emitting diode comprising:

- ✓ a transparent substrate;
- ✓ an amorphous interface layer formed on the transparent substrate;
- ✓ a top surface of the amorphous interface layer comprising a first surface region and a second surface region;
- ✓ a p⁺-type contact layer formed on the first surface region;
- ✓ a p-type cladding layer formed on the p⁺-type contact layer;
- ✓ a multiple quantum well (MQW) light-emitting layer formed on the p-type cladding layer;
- ✓ an n-type cladding layer formed on the MQW light-emitting layer;
- ✓ an n-type stop layer formed on the n-type cladding layer;
- ✓ a transparent conductive layer formed on the n-type stop layer;
- ✓ a first electrode formed on the transparent conductive layer; and
- ✓ a second electrode formed on the second surface region.

[c8] 8.A light emitting diode having a transparent substrate, the light emitting diode comprising:

- ✓ a transparent substrate comprising sapphire;
- ✓ an amorphous interface layer formed on the transparent substrate, a top surface of the amorphous interface layer comprising a first surface region and a second surface region;
- ✓ a contact layer of p⁺-type GaAs formed on the first surface region;
- ✓ a p-type cladding layer of p-type AlGaInP formed on the contact layer.

[c9] a light-emitting layer of AlGaInP formed on the p-type cladding layer;

- ✓ an n-type cladding layer of n-type AlGaInP formed on the light-emitting layer;
- ✓ a stop layer of n-type AlGaAs formed on the n-type cladding layer;
- ✓ an ITO transparent conductive layer formed on the stop layer.

[c10] a first electrode formed on the ITO transparent conductive layer.

[c11] a second electrode formed on the second surface region.

[c12] 9.A light emitting diode having a transparent substrate, the light emitting diode comprising:

an ohmic contact electrode;
a p-type transparent substrate formed on the ohmic contact electrode;
a first p^{+} -type contact layer formed on the transparent substrate;
an amorphous interface layer formed on the first p^{+} -type contact layer;
a second p^{+} -type contact layer formed on the amorphous interface layer;
a p-type cladding layer formed on the second p^{+} -type contact layer;
a light-emitting layer formed on the p-type cladding layer;
an n-type cladding layer formed on the light-emitting layer;
an n-type stop layer formed on the n-type cladding layer;
a transparent conductive layer formed on the n-type stop layer; and
a first electrode formed on the transparent conductive layer.

[c13] 10.A light emitting diode having a transparent substrate, the light emitting diode comprising:

an ohmic contact electrode;
a p-type GaP transparent substrate formed on the ohmic contact electrode;
a first p^{+} -type contact layer of p^{+} -type GaAs formed on the p-type GaP transparent substrate;
an indium tin oxide amorphous interface layer formed on the first p^{+} -type contact layer;
a second p^{+} -type contact layer of p^{+} -type GaAs formed on the indium tin oxide amorphous interface layer;
a p-type cladding layer of a p-type AlGaInP formed on the second p^{+} -type contact layer;
a multiple quantum well light-emitting layer of AlGaInP formed on the p-type cladding layer;
an n-type cladding layer of n-type AlGaInP formed on the light-emitting layer;
a stop layer of n-type AlGaAs formed on the n-type cladding layer;
an ITO transparent conductive layer formed on the stop layer;
a first electrode formed on the ITO transparent conductive layer.

[c14] 11.A light emitting diode having a transparent substrate, the light emitting

diode comprising:

a first electrode;

an n-type transparent substrate formed on the first electrode;

an amorphous interface layer formed on the n-type transparent substrate;

an n-type contact layer formed on the amorphous interface layer;

an n-type cladding layer formed on the n-type contact layer;

a light-emitting layer formed on the n-type cladding layer;

a p-type cladding layer formed on the light-emitting layer;

a p-type buffer layer formed on the p-type cladding layer;

a p⁺-type contact layer formed on the p-type buffer layer;

a transparent conductive layer formed on the p⁺-type contact layer; and

a second electrode formed on the transparent conductive layer.

[c15]

12.A light emitting diode having a transparent substrate, the light emitting diode comprising:

a first electrode;

a transparent substrate of n-type GaP formed on the first electrode;

an indium tin oxide (ITO) amorphous interface layer formed on the transparent substrate of n-type GaP;

a contact layer of n-type GaP formed on the ITO amorphous interface layer;

a cladding layer of n-type AlGaInP formed on the contact layer of n-type GaP;

a multiple quantum well (MQW) light-emitting layer of AlGaInP formed on the cladding layer of n-type AlGaInP;

a cladding layer of p-type AlGaInP formed on the MQW light-emitting layer of AlGaInP;

a buffer layer of p-type AlGaAs formed on the cladding layer of p-type AlGaInP;

a contact layer of p⁺-type GaAs formed on the buffer layer of p-type AlGaAs;

an ITO transparent conductive layer formed on the contact layer of p⁺-type GaAs; and

a second electrode formed on the ITO transparent conductive layer.

[c16]

13.A light emitting diode having a transparent substrate, the light emitting diode comprising:

a transparent substrate;

an amorphous interface layer formed on the transparent substrate, a top surface of the amorphous interface layer comprising a first surface region and a second surface region;

an n^{+} -type reverse-tunneling contact layer formed on the first surface region;

a p-type cladding layer of formed on the n^{+} -type reverse-tunneling contact layer;

a light-emitting layer formed on the p-type cladding layer;

an n-type cladding layer formed on the light-emitting layer;

a first contact electrode formed on the n-type cladding layer; and

a second electrode formed on the second surface region.

[c17]

14.A light emitting diode having a transparent substrate, the light emitting diode comprising:

a transparent substrate comprising glass;

an indium tin oxide (ITO) amorphous interface layer formed on the transparent substrate, a top surface of the ITO amorphous interface layer comprising a first surface region and a second surface region;

a reverse-tunneling contact layer of n^{+} -type InGaN formed on the first surface region;

a cladding layer of a p-type GaN formed on the reverse-tunneling contact layer of n^{+} -type InGaN;

a multiple quantum well (MQW) light-emitting layer of InGaN formed on the cladding layer of a p-type GaN;

a cladding layer of n-type GaN formed on the MQW light-emitting layer of InGaN;

a first contact electrode formed on the cladding layer of n-type GaN;

a second electrode formed on the second surface region.